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What Do We Know About the Use of Chatbots for Public Health?

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Abstract. *Background and objective*: The number of publications on the use of chatbots for health is recently increasing, however to our knowledge, there are no publications summarizing what is known about using chatbots for public health yet. The objective of this work is to provide an overview of the existing scientific literature on the use of chatbots for public health, for which purpose have chatbots been used, and whether health-related outcomes have been reported. *Methods*: We carried out a literature review on this topic across 5 databases: Pubmed, EMBASE, PsychINFO, SCOPUS, and IEEE Xplore. Identified papers were classified according to their underlying technology, application area, and study design. *Results*: A total of 15 relevant papers were identified: eight of these papers were developmental studies that tested the feasibility or usability of a chatbot, and seven were interventional studies. All the interventional studies reported positive health-related outcomes associated with the chatbot use. *Discussion*: The first studies testing chatbots for public health seem very promising; however, there are various aspects that should be improved, including the chatbots' designs, studies' methods, and analysis and reporting of results. More high-quality studies and improved reporting of chatbots' use are needed.

Keywords. Chatbot, public health, mHealth, public health informatics

1. Introduction

Public health is defined as the branch of medicine concerned with the prevention and control of disease and disability, and the promotion of physical and mental health of the population on the international, national, state, or municipal level. One of the main concerns of public health is the growing burden of chronic diseases, which highlights the urgent need to create and make available interventions that can reach large populations at a low cost [1].

Fully automated self-help interventions based on chatbots could serve as highly cost-effective health promotion interventions for large groups of people. Chatbots are computer software programs based on statistical learning, statistical analysis and educational theories aiming at simulating a human conversation by text or voice message, that are easy to use and do not require familiarity with a specific user interface. Although the number of publications on the use of chatbots for public health

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is increasing, this is still a small and emerging field [2-4], and to our knowledge, there are no publications summarizing what is known about using chatbots for public health yet.

The objective of this work is to provide an overview of the existing literature on the use of chatbots for public health, what kind of underlying technologies have been used, for which purpose have chatbots been used, and which health-related outcomes have been reported.

2. Methods

In order to get an overview of how chatbots have been used for public health purposes, we carried out a literature review in July 2019. We searched for research articles involving the use or testing of a chatbot for public health purposes, reporting results that were published from 2015 until July 2019. The search strategy covered 5 databases (Pubmed, EMBASE, PsychINFO, SCOPUS, and IEEE Xplore) and comprised the following keywords: "chatbot" or "conversational agent" or "relational agent" or "dialogue system" or "Siri" or "Alexa" or "Cortana" or "Google Home" or "Google Assistant" in combination with "public health"; "health promotion"; or "health education". Relevant identified papers were then classified according to technology, application area, and study design.

3. Results

A total of 140 publications were identified in the initial literature review. After removing duplicates, and excluding publications for being out of scope, or not reporting any clinical outcome, we ended up with 15 publications.

Among the 15 included studies, 14 were based on an own developed chatbot, and only one study used a commercially available chatbot [5]. Four studies focused on voice-only chatbots [6-9], and 11 studies used a text-based or hybrid chatbot [5, 8-17]. Voice-only chatbots for public health purposes were tested only in feasibility or usability studies and were developed to provide counselling. Only four of the chatbots were connected or integrated with different social media or website, i.e. LINE, Wikipedia, WhatsApp, and WeChat [11, 12, 17, 18], and four more referred to chatbots connected to sensors or other Apps [10, 14, 15, 19].

Regarding the study design, eight of the papers showed results related to the development of a chatbot, including usability or feasibility studies [6-12, 14]. The chatbots from these eight developmental studies focused on motivating users to control or reduce their weight [11, 14], and to provide different kind of health information, such as HPV vaccination [6], medication [7], breastfeeding [10], diabetes [12], atrial fibrillation [8], and spinal cord injury [9]. Participants involved in these eight papers described the chatbots as easy to use [6, 8], engaging [11], and were positive towards using chatbots or were satisfied with them [7-10, 12, 14].

Seven of the included papers were interventional studies where health-related outcomes linked to chatbots' use were reported [5, 13, 15-19]. All of these interventional studies used a text-based or hybrid chatbot, and the bot was used to motivate and to provide counselling on healthy lifestyles and wellness [18, 19], to improve mental health [5, 16], to reduce reproductive health preconceptions [13], to

encourage loss of weight [15], and to motivate smoking cessation [17]. Table 1 summarizes the reported health-related outcomes in these interventional studies.

Table 1. Health-related outcomes reported by the 7 interventional studies

Reference	Health domain	Reported results (intervention duration)
Gardiner [19]	Healthy lifestyle/wellness	Chatbot group: significantly decreased alcohol consumption, and increased daily fruit consumption (1 month)
Souza [18]	Healthy lifestyle/wellness	100% of participants loved the experience of receiving incentives from the chatbot (1 week)
Ly [16]	Mental health	Chatbot group: participants who adhered to the intervention showed significant positive effects on psychological wellbeing and perceived stress (2 weeks)
Inkster [5]	Mental health	Significantly improvement in symptoms of major depression and a higher proportion of positive experiences among high chatbot users (3 months)
Jack [13]	Reproductive health	Chatbot use was significantly associated with a higher proportion of preconception risks being resolved (6 months)
L'Allemand [15]	Weight control/obesity	70% of participants had >4 interactions per day with the chatbot, and 37% of the daily challenges were completed successfully (4 months)
Wang [17]	Smoking cessation	Chatbot groups: much higher quit rates (2 months)

4. Discussion

Fifteen relevant papers on the use of chatbots for public health were identified in a literature review. Eight of them were developmental studies that only tested the feasibility or usability of a chatbot, while seven were interventional studies. All the interventional studies used a text-based or hybrid chatbot and reported benefits linked to its use, including significant increase in fruit consumption and wellbeing, improvement in depression symptoms, higher proportion of preconception risks solved, and higher smoking quit rates; as well as significant decrease in alcohol consumption, and positive experiences with interacting with the chatbot.

Nowadays, the role of chatbots in the public health system is still limited. Nonetheless, chatbots could provide auxiliary care through providing counselling and encouraging self-management of illness [3], adherence to treatment [20] or administrative services such as scheduling appointments [21], among others. With the continuous advancement in technology and behavioural sciences research, the competency and trustworthiness of chatbots are expected to be increased and promote its use in more complex and significant tasks in the health organizations [3]. First studies testing chatbots for public health seem very promising; however, there are various aspects that should be improved, including the chatbot design, study methods, and analysis and reporting of results.

Regarding the chatbot design, although there is evidence showing higher effectiveness of digital interventions when they are linked, integrated or delivered

through social media [22-24], only a few studies connected or integrated the chatbot to social media or other apps. The connection of chatbots to social media and integration of information from various apps and sensors would make chatbots more tailored to each individual, substantially enhancing the usefulness and motivation for the users to relate to chatbots – thus better possibilities to improve health parameters.

On the study methods, very few studies carried out an intervention, and many of these papers were of very short duration (down to 1 week), and consequently, increasing the likeliness that the positive effects were caused by the "Hawthorn effect" [25]– not the chatbot. More randomized trials should be done on this topic, and future research should increase the duration of the interventions to prove its sustained effect over time.

Better analysis and reporting of results are also needed. It is important to take into account that two of the papers that reported benefits, both of them testing the chatbot in the field of mental health, reported that the positive effect was only present in participants who adhered to the intervention, or that had higher use of it [5, 16]. Adherence to digital interventions is correlated with the characteristics of the innovation, and also with participants' interest towards it [26]. Therefore, and in order to move this field forward, it is relevant that researchers report, analyze and discuss usage metrics and determinants of attrition linked to the chatbots use in health interventions [26]. Security issues related to the chatbot are also a relevant issue that was unconsidered or unreported in the included papers, even though security is crucial in the health domain, and especially relevant for systems that are collecting or processing data from a user. Another security risk that needs further consideration is the possibility of chatbots to motivate the user to do actions that could be dangerous for the individual (e.g. obese person with type 1 diabetes who wants to lose weight, not eating due to encouragement from a chatbot – ending up in hypoglycemia – hospitalized or even dying). Who assumes responsibilities for these risks and the possible dangers, and therefore must be addressed by researchers?

Our literature review has covered five databases; however, we might have missed additional relevant publications on the use of chatbots for public health. Future reviews should expand the scope of the search and incorporate research projects that are being carried out currently, in order to have a better overview of the potential different uses and benefits that chatbots could have for public health in the near future.

Although there are promising results, there is not enough evidence supporting the use of chatbots for public health yet. More high-quality studies and improved reporting of chatbots' use are needed.

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